# "DESIGN STRATEGIES IN MEETING FCC EMISSION STANDARDS FOR EDP EQUIPMENT"

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FOR
RFI/EMC FORUM
MARRIOTT HOTEL
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## FORWARD

I regret that I cannot personally give the talk scheduled for this first one day forum on RFI/EMC. A schedule conflict has prevented me from being present as I had hoped to be.

## ABOUT CHRIS KENDALL CONSULTANTS

CHRIS KENDALL CONSULTANTS is a firm that specializes in design techniques for solving EMC emission and susceptibility proboems. They have a staff of experienced EMC design engineers and test engineers for this purpose. The staff concentrates on both commercial and military EMC techniques. The staff has taught numerous EMC courses throughout the world and have consulted to over 200 different companies and government agencies during the past 9 years. They maintain a fully equiped, FCC authorized open field test range in the San Bernardino Mountains in Southern California where they perform FCC, CISPR, and German VDE certification testing and design assistance. This organization has developed the math models and verification testing of EMCad, a computer software system for analyzing designs to determine if they are compliant to both commercial and military EMC standards.

## FCC REQUIREMENTS

FCC Volume II, dated July 1981, Part 15, Subpart J is entitled "Computing Devices". The applicable paragraph numbers are 15.801 through 15.838. This subpart defines both the limits and test methods required for all computing devices sold in the United States.

## FCC EQUIPMENT AUTHORIZATION PROCEDURES

Part 15, Subpart J requires "certification" for Class B products. Paragraph 2.907 of Volume II defines "certification" as:

> a) Certification is an equipment authorization issued by the Commission for equipment designed to be operated without individual license under Parts 15 and 18 of its rules based on representations and test data submitted by the applicant.

b) Certification attaches to all units subsequently marketed by the grantee which are identical (see P. 2.908) to the sample tested except for permissive changes or other variations authorized by the commission pursuant to P. 2.1043.

To achieve "certification" the following steps are required:

1) Test your product for Part 15, Subpart J procedures. If the conducted and radiated emission levels are below the stipulated limits then a report of measurement should be generated per Appendix A to Subpart J, Paragraph 4.4. (Page 167 FCC Rules and Regulations)

2) Submit a written application (or have test lab do same by acting as your agent) per paragraph 2.909. Submit same to:

FCC LABS
P.O. Box 429
Columbia, MD. 21045

3) For Class B products, submit a sample unit along with the application.

4) If FCC accepts your data and product then they will issue you a "Grant of Equipment Authorization" on FCC form 731A. Form 731A will state the FCC identifier number and the date of grant. Typical time laps between the date of application and the date of grant is three months.

## FCC APPLICATION INFORMATION LIST

The application for "certification" must include the following:

1) Completed 731 form (attached).

2) Sketch of leabel and description of location (Ref. Para. 2.925 and 2.926 FCC Rules and regulations.

3) Fees per Subpart G of Part 1 of this chapter (ref. 15.34) presently are required.

4) Technical report per Para. 15.44.

FCC Form 731
March 1976

FEDERAL COMMUNICATIONS COMMISSION
Washington, D. C. 20554

Approved By GAO
B-180227(R0351)

This form may be reproduced ONLY in accordance with the requirements on reverse side of this application.

# APPLICATION FOR EQUIPMENT AUTHORIZATION-RADIOFREQUENCY DEVICES

## INSTRUCTIONS

A. Use this form as a cover sheet and attach the information required by Subpart J of Part 2, Part 15, or Part 18 of FCC Rules, enumerating the exhibits in Item 9 below.

B. Submit ONE COPY of the completed application, together with the fee required (See §§ 1.1102 and 1.1120 of FCC Rules) to: Federal Communications Commission, P. O. Box 19302, Washington, D. C. 20036.

1. Application is for *(check only one box)* ☐ Certification ☐ Type Acceptance ☐ Type Approval

2. (a) Name of Applicant

(b) Address of Applicant (number, street, city, state, zip code)

(c) To the attention of

3. Name and address of person to whom authorization is to be sent (if different from Item 1)

4. Name and address of manufacturer of equipment (if different from Item 1)

5. (a) Kind of equipment

(b) Power Supply *(check one)* ☐ AC ☐ Battery ☐ Other *(specify)* ____________

(c) Trade Name(s)

(d) Model Number(s) or Type Number

| | YES | NO |
|---|---|---|
| 6. (a) Is this application for a modification of a previously type approved equipment or for a change in its identification? | | |
| (b) If "YES," state the previous identification of the equipment | ▨ | ▨ |

7. EQUIPMENT SPECIFICATIONS

| | |
|---|---|
| (a) Frequency range | (b) Rated RF power output (if variable, give range) |
| (c) Power input to final RF amplifier (if applicable) | (d) Rated frequency tolerance |

APPLICANT SHOULD NOT USE THIS BLOCK

| | |
|---|---|
| | ACCOUNTING CLASSIFICATION |

*(This form supersedes FCC Forms 722, 723, and 729.)*

- over -

5) Expository statement per Para. 15.45.

6) Photographs per Para. 15.46.

7) Report of Measurement per Appendix A to Subpart J, Paragraph 4.4 (Page 167).

8) Description of measurment facilities (per Para. 15.38) if not already on file with FCC.

9) Letter of agents appointment.

The techical report shall contain the following:

1) Name and address of manufacturer.

2) Device Trade Name (s)

3) Model Number (s).

4) Installation and operating instructions furnished to the user.

The expository statement (15.45) shall contain the following:

1) Block diagram with crystal oscillators locations identified together with their frequency.

2) Statement of how the device operates.

3) Circuit diagram.

4) Description of circuitry in the device.

Photographic requirements (15.46) are:

1) Attach a sufficient number to show:

   - Exterior appearance
   - Construction
   - Component placement
   - Chassis assembly.

## CASE DESIGN APPROACH

The three basic design approaches for commercial units are:

1) Full exterior case shield.

2) Compartmentize shielding with shielded interconnects.

3) Common mode impedance control of all circuits and interconnect.

Amount of required shielding effectiveness is shown in attached Table.

## EXTERIOR CASE SHIELDING

1) To achieve this goal, cases of metal require electrical contact at approximately every 6" - 8".

2) Conductive paint also will achieve this goal approximately 1 - 5 ohms sqaure. Nickel acrylic paint is very popular.

3) Metalization is also good, but may have a safety problem if flaking occurs.

4) Many cases only require the bottom to be painted if microprocessor board is located in the bottom half of the cabinet.

## COMPARTMENTIZED SHIELDING

1) An open frame structure, 1 - 2 square inches is acceptable - sometimes more.

2) Single sided shielded cable often is acceptable for short interconnects providing the shield is grounded at both ends to shielded components.

## I/O CABLES

1) All I/O cables require shielding or pin filtering, common mode.

2) Beldfoil type shielding is excellent.

TABLE 5.0-1
FCC REQUIRED SHIELDING

| CIRCUIT | CATEGORY A |  |  | CATEGORY B |  |  |
|---|---|---|---|---|---|---|
|  | 30MHz-100MHz | 100MHz-300MHz | 300MHz-1GHz | 30MHz-100MHz | 100MHz-300MHz | 300MHz-3GHz |
| CRT VIDEO | 41 | 27 | 2 | 50 | 32 | 10 |
| CRT YOKE DRIVE | -40 | NA | NA | -30 | NA | NA |
| PRINTER PRINTHEAD | -10 | -26 | NA | -1 | -15 | NA |
| PRINTER STEPPERMOTOR | -40 | NA | NA | -30 | NA | NA |
| LED DISPLAY | -27 | NA | NA | -18 | NA | NA |
| PLASMA DISPLAY | 19 | -9 | -25 | 28 | 8 | 2 |
| 10-20kHz SWITCHER SUPPLY | -9 | -25 | NA | 1 | -14 | NA |
| 20-50kHz SWITCHER SUPPLY | -3 | -20 | NA | 7 | -9 | NA |
| 50kHz-100kHz SWITCHER | 3 | -14 | NA | 14 | -2 | NA |
| BIT SLICE UP (2900) | 28 | 14 | -6 | 38 | 24 | 8 |
| GP UP (2900) | 8 | -12 | NA | 28 | -2 | NA |
| CMOS UP (1802 | 2 | -18 | NA | 12 | -8 | NA |
| 100-200 NSEC MEMORY | 31 | 11 | -9 | 41 | 21 | 2 |
| 200-500 NSEC MEMORY | 18 | -1 | NA | 27 | 8 | -12 |
| 500-700 NSEC MEMORY | 4 | -17 | NA | 13 | -6 | NA |
| FIXED DISK (1-10MHz DATA RATE) | 12 | -1 | NA | 22 | 8 | -11 |
| FLOPPY DISK (500kHz-2MHz) | 3 | -16 | NA | 13 | -6 | NA |
| INTERCONNECT (.5MHz RATE) | 8 | -14 | NA | 18 | -4 | NA |
| INTERCONNECT (5MHz RATE) | 26 | 12 | -8 | 36 | 22 | 2 |

3) Zippertubing materials work well also.

4) Braids generally work, but not always.

5) For ESD we recommend metal connectors or conductively painted connectors - prefer no lead exposure.

## FILTERS

1) There are many filter manufacturers.

2) Linear power supplies need little or no filtering.

3) Switcher power supplies need considerable filtering.

4) Common mode designs are best where small leakage current requirements exist.